SOME WATER-SOLUBLE VITAMIN DEFICIENCIES OF A CORN-SOYBEAN MEAL RATION FOR WEANLING PIGS

BY

IRWIN ALLEN DYER

B.S.A., University of Georgia, 1946
M.S.A., University of Georgia, 1947

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ANIMAL SCIENCE
IN THE GRADUATE COLLEGE OF THE
UNIVERSITY OF ILLINOIS, 1950

URBANA, ILLINOIS

1950

SOME WATER-SOLUBLE VITAMIN DEFICIENCIES OF A CORN-SOYBEAN MEAL RATION FOR WEANLING PIGS

BY

IRWIN ALLEN DYER

B.S.A., University of Georgia, 1946
M.S.A., University of Georgia, 1947

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ANIMAL SCIENCE
IN THE GRADUATE COLLEGE OF THE
UNIVERSITY OF ILLINOIS, 1950

URBANA, ILLINOIS

1950

ACKNOWLEDGMENTS

The writer wishes to express his sincere appreciation to his advisers, Drs. J. L. Krider and W. E. Carroll for their aid and counsel in conducting these experiments. The writer is particularly indebted to Dr. Krider for relinquishing space and providing pigs and different feed ingredients used in this study.

He is also indebted to the following:

Drs. L. E. Card, T. S. Hamilton and S. W. Terrill for their generous advice in planning the experiments and in preparation of this thesis.

Dr. L. E. Boley and members of the Veterinary Staff for medical advice, treatment and autopsy of pigs as the need arose.

R. H. McDade, swine herdsman, and his associates for their assistance.

W. T. Haines and his co-workers for the chemical analyses of rations.

Appreciation is also expressed to the following companies for funds and products as specified: A. E. Staley Manufacturing Company, Decatur, Illinois, for supplying soybean meal used in experimental work;

R. UNIV. BIBLIOTHEEK LEIDEN

Central Soya Company, Inc., Gibson City, Illinois, for supplying the condensed menhaden fish solubles and soybean meal; Western Condensing Company, Appleton, Wisconsin, for supplying the dried whey product with whey fermentation solubles; American Dry Milk Institute, Chicago, 1, Illinois, for the dried skim milk; Commercial Solvents Corporation, Terre Haute, Indiana, for the penicillium meal and dried fermentation solubles (BY-21); and Hiram Walker and Son, Inc., Peoria, Illinois, for dried corn distillers' solubles.

Appreciation is expressed to the Lederle Laboratories, Pearl River, New York, for providing a vitamin B_{12} concentrate and a portion of the crystalline thiamine, riboflavin, niacin, pantothenic acid and choline chloride; Merck and Company, Inc., Rahway, New Jersey, for contributing a B_{12} concentrate as well as riboflavin, niacin, pyridoxine and choline chloride; and Eli Lilly and Company, Indianapolis, Indiana, for the reticulogen (20 unit anti-pernicious amenia liver extract).

The writer is indebted to his wife, Allene, for her constant encouragement and understanding and to his daughter, Barbara, for inspiration.

Digitized by the Internet Archive
in 2026

https://archive.org/details/IA41549816_0109

SOME WATER-SOLUBLE VITAMIN DEFICIENCIES OF A CORN-SOYBEAN MEAL RATION FOR WEANLING PIGS

Various investigators have reported the inadequacy in certain water soluble factors of a corn-soybean meal ration for weanling pigs. Krider et al (1944) stated that an all-plant ration is deficient in vitamins of the B_2 complex. Dyer et al (1949) have shown such a ration to be deficient in labile methyl groups while Luecke et al (1949) and others have reported that all-plant rations are deficient in an unidentified growth factor(s) required for optimum performance by pigs.

The objects of these tests were:

1. To study the effect on the growth rate and well-being of pigs when vitamins of the B complex were added, singly and in combination, to a corn-soybean meal ration supplemented with minerals and vitamins A and D.

2. To study the interchangeability of choline and betaine and the effect of choline, betaine and methionine on the growth rate when added to a corn-soybean meal ration.

3. To compare certain vitamin B_{12} concentrates, and assay and compare natural feed supplements as sources of supplementary growth factor(s) for growing-fattening pigs.

4. To compare expeller soybean meal with solvent soybean meal as protein supplements for weanling pigs.

Pigs on the growing-fattening experiments were group fed in drylot with feed and water supplied *ad libitum*. The rations fed to weanling pigs contained 20% crude protein, while those fed to gilts on the gestation-lactation study contained 17% crude protein.

TABLE I.

Composition of the Basal Rations Used In the Growing-Fattening and Gestation-Lactation Experiments

Ingredients	Growing-Fattening Experiments	Gestation-Lactation Experiment
	%	%
Ground yellow corn	63.5	71.0
Expeller soybean meal	34.0	25.5
Complex mineral mixture (H & K)	2.0	2.0
Steamed bone meal	——	1.0
Vitamin A and D oil	0.5	0.5

In the first experiment, consisting of 6 lots of 8 weanling pigs each carried to a final weight of 75 pounds, the pigs on the basal ration (no crystalline vitamins of the B complex were included) gained at a slow rate, had rough hair coats, dermatitis and incoordinated gaits. The performance of such pigs was significantly improved by the addition of 1.5 mg. riboflavin per pound of ration. The further addition of 6 mg. of pantothenic acid and 250 mg. of choline chloride per pound of feed significantly increased the rate of gain over that produced by pigs receiving the basal ration plus riboflavin. The further addition of 6 mg. thiamine, 5 mg. niacin and 2.5 mg. pyridoxine per pound of ration had no appreciable affect on the rate of gain, thrift or feed required per 100 pounds gain.

A second experiment, consisting of 4 lots of 12 pigs each, was conducted to study the effect of adding choline or methionine to the corn-soybean ration which included thiamine, riboflavin, niacin, pantothenic acid and pyridoxine. A highly significant ($P \leq .01$) increase in the rate of gain to a final weight of 100 pounds over that produced by the basal ration occurred when either 25 g. choline, .2 lb. dl-methionine or a combination of both was fed per 100 pounds of feed.

In another test with weanling pigs in which a vitamin B_{12}

concentrate (equivalent to 12.5 mcg. vitamin B_{12} activity per pound of feed) was fed, the addition of either 25 g. choline or 21 g. betaine per 100 pounds of feed did not improve the ration.

Six experiments were conducted with weanling pigs in which various concentrates and supplements were compared as sources of vitamin B_{12} and/or unidentified factor(s). In two of these experiments in which lots of 12 pigs were fed to final weights of 75 or 100 pounds, the basal ration including 6 vitamins of the B complex was only slightly improved by the addition of either 5% meat scraps or 2% dried whey product with whey fermentation solubles. However, a combination of these two products produced a significant response in the rate of gain, as did also condensed menhaden fish solubles fed as 2% of the ration to a weight of 75 pounds. Beyond that weight, however, the solubles were without significant effect. The addition of 4% penicillium meal had no effect on the rate of gain, while either 8% dried skim milk or a combination of 4% dried skim milk and 2.5% meat scraps significantly improved the growth rate. Pigs in the basal lot exhibited no deficiency symptoms other than a slower rate of gain.

Gilts receiving either 5% meat scraps, 2% dried whey product with whey fermentation solubles, a combination of these two products, 2% condensed fish solubles or 4% penicillium meal were retained on their respective rations for gestation-lactation studies. No differences were observed in growth rate between weights of 100 and 200 pounds that appeared to be associated with the rations fed, indicating that the critical period, nutritionally, is past before the pigs reach 100 pounds live weight.

In another experiment where the 20% crude protein basal ration (including 6 vitamins of the B complex) was fed, Lederle's "APF" concentrate (fuller's earth adsorbate) fed at the 1% level increased the rate of gain, while 1% of Merck's "APF" concentrate (charcoal adsorbate) was apparently unpalatable and did not increase the rate of gain. A combination of 1% condensed menhaden fish solubles and 4% dried corn

distillers' solubles appreciably improved the rate of gain as well as the general appearance of the pigs.

When folic acid was added to the above basal ration which contained 6 vitamins of the B complex, either 5% meat scraps or a combination of 4% dried whey product with whey fermentation solubles and 5% meat scraps slightly improved the performance of pigs. Merck's vitamin B_{12} concentrate (12.5 mg. vitamin B_{12} activity per pound) fed at the .05% level slightly improved the rate of gain while 1.1% of Lederle's B_{12} concentrate (4 - 5 mg. vitamin B_{12} activity per pound) significantly improved the rate of gain. Pigs on this treatment were uniform, thrifty and had very sleek hair coats. Feed efficiency was very satisfactory among the 5 lots, ranging from 256 to 285 pounds of feed per 100 pounds of gain.

To determine whether vitamin B_{12} was essential for optimum growth when the basal ration including 9 vitamins of the B complex was fed, 1 cc. reticulogen (20 unit anti-pernicious anemia liver extract) was injected per pig per week. The injection of reticulogen, equivalent to 2.7 mcg. per pig per day, did not improve the rate of gain, feed required per 100 pounds gain, or general appearance over the control pigs.

To determine whether expeller soybean meal or solvent soybean meal was superior for growing-fattening pigs, 3 lots of 9 pigs each were fed an expeller soybean meal while 3 comparable groups received solvent soybean meal fed to supply the same amount of crude protein in the ration. The difference in daily gains very significantly favored the solvent soybean meal.

Gilts fed a 17% crude protein corn-soybean meal ration plus 6 vitamins of the B complex during gestation-lactation gave a very significantly superior performance, as measured by the number of gilts that farrowed, when either 5% meat scraps, 2% dried whey product with whey fermentation solubles, a combination of these two products, 2% condensed menhaden fish solubles or 4% penicillium meal was added to

the basal ration. All gilts receiving the basal ration failed to conceive, indicating that the basal ration was deficient in a factor(s) needed for normal reproduction.

Conclusions

Under the conditions imposed in these experiments the following conclusions seemed justified:

1. A corn-soybean meal ration formulated to contain 20% crude protein was deficient in riboflavin and pantothenic acid for optimum growth of weanling pigs.

2. The thiamine, niacin and pyridoxine content of this ration was adequate for the weanling pig.

3. The level of choline (.13%) in this diet satisfied the indispensable choline requirement but did not supply a sufficient amount of labile methyl groups for optimum growth in the absence of a vitamin B_{12} supplement.

4. Above the indispensable requirement of choline, it is suggested that choline, methionine and betaine (fed to supply an equal amount of methyl groups) are interchangable in the ration of weanling pigs, since choline and methionine produced results which did not differ significantly from each other, and in another test choline and betaine produced very similar results.

5. Either 25 g. choline chloride or 21 g. betaine added per 100 lb. of feed to the corn-soybean meal ration plus 6 vitamins of the B complex had no significant effect on growth when vitamin B_{12} was included in the ration, suggesting that vitamin B_{12} has a sparing effect on the choline requirement of the pig.

6. Certain vitamin B_{12} concentrates enhance the growth rate of weanling pigs. The increased growth rate and the freedom from enteric disturbances when pigs were fed the Lederle's "APF" concentrate (4 - 5 mg. vitamin B_{12} activity per pound) suggests the presence of a growth factor other than vitamin B_{12}, certain antibiotic properties or both in this product.

7. Weanling pigs on a natural diet, otherwise complete, did not respond favorably to a reticulogen injection (1 cc. per pig per week which was equivalent to 2.7 gamma vitamin B_{12} per pig daily). These results suggest that intestinal synthesis, under these conditions, can supply the vitamin B_{12} needed to supplement the ration.

8. The weanling pig requires unidentified factor(s) for optimum growth.

9. Meat scraps and dried whey product with whey fermentation solubles each contain an unidentified growth factor(s) required by pigs. The increase in growth rate is attributed to the "animal protein factors" in meat scraps and factor S (whey factor) in the whey product.

10. Dried skim milk contains both the "APF" and factor S.

11. Condensed menhaden fish solubles contain both the "APF" and factor S although from the performance of pigs receiving this product it is suggested that the potency of at least one of these factors is variable.

12. Penicillium meal evidently does not contain an unidentified growth factor(s) for pigs but apparently does contain an unidentified factor required for optimum gestation-lactation performance of sows.

13. Solvent soybean meal is superior to expeller soybean meal for growth when fed to supply the same quantity of protein.

14. A corn-soybean meal ration fortified with 6 vitamins of the B complex was nutritionally inadequate to support normal reproduction in gilts. This ration was significantly improved by the addition of either meat scraps, dried whey product with whey fermentation solubles, condensed menhaden fish solubles or penicillium meal.

LITERATURE CITED

Dyer, I.A., J.L.Krider and W.E.Carroll. 1949. Known and Unidentified Factors Supplement a Corn-Soybean Meal

Ration for Weanling Pigs in Drylot. Jour. Animal Science. (In Press).

Krider, J.L., B.W.Fairbanks and W.E.Carroll. 1944. The Nature of the Deficiencies of an all Plant Ration for Weanling Pigs in Drylot. Jour. Animal Science 3: 454. (Abstract).

Luecke, R.W., W.N. McMillen, F.Thorp, Jr., and J.R. Boniece. 1949. The Effect of Vitamin B_{12} Concentrates on the Growth of Weanling Pigs Fed Corn-Soybean Meal Diets. Science 110: 139 - 140.

VITA

Irwin Allen Dyer was born February 8, 1921 and reared on a farm near Dahlonega, Georgia. He attended the Consolidated School at Dahlonega for 11 years, graduating in 1938.

From August 1938 to June 1940 he attended the Rabun Gap Junior College, and from August 1940 to June 1941 he attended West Georgia College.

He taught the seventh grade and was Director of High School Athletics at the Rabun Gap Consolidated School from August 1941 to June 1942.

From June 1942 to July 1943 he attended the University of Georgia.

He served in the Navy from August 1943 to March 1946 after which he returned to the University of Georgia and received his Bachelor of Science in Agriculture in August 1946. From August 1946 to August 1947 he was a graduate assistant in the Animal Husbandry Department and received his Master of Science in Agriculture in August 1947.

In September 1947 he entered the University of Illinois, where he began working toward the degree of Doctor of Philosophy and served as an assistant in the Animal Science Department. His graduate work consisted of a major in Animal Science, a first minor in Animal Nutrition and a second minor in Agronomy.

He was married to Miss Allene Hodgson, Athens, Georgia, on November 26, 1943.